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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/807,190	03/24/2004	Takeshi Yamamoto	57810-091	3715

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600 13th Street, N.W.
Washington, DC 20005-3096

EXAMINER

TRINH, THANH TRUC

ART UNIT	PAPER NUMBER
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1795

MAIL DATE	DELIVERY MODE
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10/04/2010

PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary**Application No.**

10/07,190

Applicant(s)

YAMAMOTO ET AL.

Examiner

THANH-TRUC TRINH

Art Unit

1795

Period for Reply -- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 12 July 2010.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1, 3, 4, 6, 10 and 12 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1, 3-4, 6, 10 and 12 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO/GS/US)
- 4) ☐ Interview Summary (PTO-413)
- 5) ☐ Notice of Informal Patent Application
- 6) ☐ Other: _____
- Paper No(s)/Mail Date _____

DETAILED ACTION

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(c), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(c) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 7/12/2010 has been entered.

Claim Rejections - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

4. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various

claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

5. Claims 1, 3-4, 6, and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sakata et al. (US 2001/0008295) in view of Kloppel et al. (US 20030170449), Kataoka et al. (US Patent 6133522), and Yamazaki (US patent 4746962), and further in view of Minoru (JP 2002-305212, see machine translation)

Regarding claims 1, 6, 10, as seen in Figures 1-2, Sakata et al. teaches a photovoltaic device comprising a photovoltaic element comprising:

- a first conductivity type of single crystalline silicon semiconductor layer (e.g. 1 as seen in Figures 1-2);
- a substantially intrinsic non-single-crystalline semiconductor layer (or i-type a-Si layer 2 in Figure 1, 2 and 7 in Figure 2) formed on the first conductivity semiconductor layer;
- a transparent conductive oxide film (transparent electrode 5 made of ITO, or SnO₂ added In₂O₃ in Figure 1, 5 and 10 in Figure 2 - See paragraphs 0036, 0062), and
- a collector electrode of comprising Ag (See paragraph 0036).

As seen in Figures 1-2, Sakata et al. teaches a surface of the crystalline semiconductor layer (1) is textured so that irregularities of the crystalline semiconductor is higher than the

thickness of the transparent conductive oxide film (5) of 600-1500 Angstroms (or 60 nm - 150 nm - See paragraph 0036). The irregularities of the crystalline semiconductor layer are inherently higher than the height of the irregularities on the surface of the transparent conductive oxide film.

Sakata et al. does not specifically disclose the content of Sn in the transparent conductive oxide is not more than 5 percent by weight.

Yamazaki teaches a content of SnO₂ (tin oxide) in a transparent conductive oxide electrode of a solar cell is about 1-10 wt% (See col. 6 lines 21-24, or col. 9 line 33-34), or the Sn (e.g. tin) content is about 0.788-7.88 wt%.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to select the portions in Yamazaki's range corresponding to the claimed range of not more than 5 percent by weight for the content of Sn in the transparent conductive oxide (e.g. ITO), because Yamazaki's disclosed range of 1-10 wt% of Sn in the transparent conductive oxide is suitable. Such selection of overlapping portion of ranges has been held to be a prima facie case of obviousness. *In re Malagari*, 182 USPQ 549. Furthermore, while modified Sakata et al. teaches the broader range of Sn content, the references do not teach the exact range of Sn content of not more than 5 percent by weight. However, the routine experimental modification of modified Sakata et al. done in order to ascertain optimum operating conditions of disclosed device fails to render applicant's claims patentable in the absence of unexpected results. See *In re Aller*, 105 USPQ 233 and MPEP 2144.05. At the time of the invention a person having ordinary skill in the art would have found it obvious to optimize the Sn content in the transparent conductive oxide of modified Sakata et al and would have been motivated to do so in order to

balance such operating conditions as efficiency of the device and conductivity of the transparent conductive oxide film. A prima facie case of obviousness may be rebutted, however, where the results of the optimizing variable, which is known to be result-effective, are unexpectedly good. See *In re Boesch and Slaney*, 205 USPQ 215.

Modified Sakata et al. above does not specifically disclose the transparent conductive oxide (ITO) film having an arithmetic mean deviation of the profile (or mean surface roughness) of at least 0.5 nm and not more than about 2 nm, or at least about 0.5 nm and not more than about 1 nm.

Kloppel et al. teaches the transparent conductive oxide film of ITO having an arithmetic mean deviation of the profile (or surface roughness) of less than 1 nm. (See paragraph [0013]).

It would have been obvious to one skilled in the art at the time the invention was made to modify the device of modified Sakata et al. by having an arithmetic mean deviation of the profile of the transparent conductive oxide film (or surface roughness of ITO film) less than 1 nm as taught by Kloppel et al. because Kloppel et al. teaches such roughness would avoid spikes thereby enhancing conductivity and adhesion of the film (see paragraphs 0005-0006 of Kloppel et al.) and selecting the portions in Kloppel et al.'s range corresponding to the claimed ranges of at least 0.5 nm to not more than 2 nm or at least 0.5 nm to not more than 1 nm, because Kloppel's disclosed range of less than 1 nm is suitable. Such selection of overlapping portion of ranges has been held to be a prima facie case of obviousness. *In re Malagari*, 182 USPQ 549. While modified Sakata et al. teaches the range of the arithmetic mean deviation of the profile of the transparent conductive oxide to be less than 1 nm, the references do not teach the exact ranges of at least 0.5 nm to not more than about 2 nm or at least 0.5 nm to not more than about 1

nm. However, the routine experimental modification of modified Sakata et al. done in order to ascertain optimum operating conditions of disclosed device and particularly of the disclosed transparent conductive oxide film fails to render applicant's claims patentable in the absence of unexpected results. See *In re Aller*, 105 USPQ 233 and MPEP 2144.05. At the time of the invention a person having ordinary skill in the art would have found it obvious to optimize the arithmetic mean deviation of the profile (e.g. surface roughness) of the transparent conductive oxide of modified Sakata et al and would have been motivated to do so in order to balance such operating conditions as efficiency of the device and conductivity of the transparent conductive oxide. A prima facie case of obviousness may be rebutted, however, where the results of the optimizing variable, which is known to be result-effective, are unexpectedly good. See *In re Boesch and Staney*, 205 USPQ 215. Once the selecting the portions in Kloppel et al's range of less than 1 nm corresponding to the claimed range of at least 0.5 nm to not more than 2 nm (i.e. from 0.5 nm to 1 nm) was made, the transparent conductive oxide film of modified Sakata et al. has a surface with respect to which a contact angle of water is at least about 40° and not more than about 74°, particularly in view of Applicant's disclosure (see Applicant's specification, page 35 line 23 through page 36 line 8, and Figure 8)

Modified Sakata et al. above does not specifically disclose a paste electrode formed on the transparent oxide film, wherein the paste electrode contains at least 60 percent by weight and not more than 80 percent by weight of epoxy resin; and an electric wire connected to the paste electrode by solder.

Kataoka et al. teaches a collector electrode (505) formed on the transparent conductive oxide of ITO (504), wherein the silver collector electrode in a form of paste electrode of silver

and a resin material (epoxy). (See col. 9 lines 10-29). Kataoka et al. also teaches a copper tab or a tin foil (506a) attaching to the paste electrode 505 by solder. (See col. 9 lines 30-37 or col. 14 lines 37-47). The copper tab or tin foil is corresponding to the instant electric wire. Minoru is relied upon for teaching a silver conductive paste containing thermosetting resin, wherein the thermosetting resin consist of about 60-80 wt% by weight of epoxy resin (see weight ratio of epoxy to urethane is between 10:2 to 5-10:5 in paragraph 0011 and claim 2) in the blending of epoxy and urethane resin. (See Minoru, paragraph 0011 and claim 2). It is noted that the thermosetting resin of Minoru corresponds to the instant resin binder which consist of urethane and epoxy resin.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify to device of modified Sakata et al. above by having the paste electrode of silver and epoxy resin and the electric wire connected to the paste electrode by solder as taught by Kataoka et al. with the silver conductive paste containing 60-80 wt% of epoxy in the mixture of epoxy and urethane as taught by Minoru, because Kataoka et al. teaches the electric wire such as copper tab 506a is used as an output terminal (See col. 9 lines 30-37 of Kataoka et al.) and using silver conductive paste for the electrode is nothing more than selection of a known material for its intended use which is within the ambit of one ordinary skill in the art. See *In re Leshin*, 125 USPQ 416 (CCPA 1960) (See MPEP 2144.07), and Minoru teaches the composition of silver conductive paste containing 60-80wt% epoxy would have low stress nature and heat-resistant reliability (see paragraph 0024 of Minoru).

Regarding claim 3, as seen in Figures 1-2, modified Sakata et al. discloses a photovoltaic device as described in claim 1 above, wherein Sakata et al. further teaches the photovoltaic

element further comprising a second conductivity type non-single-crystalline semiconductor layer (or p-type a-Si layer 4) formed on the intrinsic non-single-crystalline (2) and the transparent conductive oxide film (5) is formed on the second conductivity type non-single-crystalline semiconductor layer (4).

Regarding claim 4, as seen in Figure 2, modified Sakata et al. discloses a photovoltaic device as described in claim 1 above, wherein Sakata et al. further teaches the intrinsic non-single-crystalline semiconductor layer (i-type a-Si layers 2 and 7) includes first (2) and second (7) intrinsic non-single-crystalline semiconductors formed on the upper and lower surfaces of the first conductivity type single crystalline semiconductor layer (1), respectively; a second conductivity type non-single crystalline (p-type a-Si layer 4) formed on the upper surface of the first intrinsic non-single-crystalline semiconductor layer (2); a first conductivity type fourth non-single crystalline semiconductor layer (n-type a-Si semiconductor layer 9); and the transparent conductive oxide film (5 and 10 as seen in Figure 2, paragraph 0062) including a first transparent conductive oxide film (5) formed on the upper surface of the third non-single crystalline semiconductor layer (4) and a second transparent conductive oxide film (10) formed on the lower surface of the fourth non-single crystalline semiconductor layer (9) .

6. Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Sakata et al. (US 2001/0008295) in view of Kloppel et al. (US 20030170449), Kataoka et al. (US Patent 6133522), Yamazaki (US patent 4746962), and Minoru (JP 2002-305212) as applied to claims 1, 3-4, 6, and 10 above, and further in view of Morizane et al. (US 2001/0045505)

Regarding claim 12, modified Sakata et al. teaches a photovoltaic device as set forth above, wherein Kataoka et al. describes a plurality of the photovoltaic elements provided at a prescribed interval and connected in series by electric wires (copper tab and tin foil), wherein the photovoltaic element includes a first paste electrode (formed on the upper surface of photovoltaic element. (See Figures 1 and 5, col. 14 lines 37-47).

Modified Sakata et al. does not teach a second paste electrode formed on the lower surface of the photovoltaic element.

Morizane et al. teaches using a second collector electrode (18). (See Figure 1 and paragraph [0052])

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the device of modified Sakata et al by utilizing the second collector electrode as taught by Morizane et al., because it would enable light to enter from both front and rear surfaces. (See paragraph [0051]). In such a combination, it would have been the second collector electrode can be a paste collector electrode like the first collector electrode 505 of Kataoka et al. It also would have been obvious to one having ordinary skill in the art at the time the invention was made to connect the first end of the electric wire (copper tab or tin foil) to the first paste electrode of one cell and the second end of the electric wire to the second paste electrode of another cell as taught by Morizane et al., because in this way the photovoltaic elements are connected in series as taught by Kataoka et al.

7. Claims 1, 3-4, 6 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sakata et al. (US 2001/0008295) in view of Kataoka et al. (US Patent 6133522), Yamazaki (US patent 4746962) and Kawai (JP 58-56479, see English abstract), and further in view of Minoru (JP 2002-305212, see machine translation)

Regarding claims 1, 6, and 10, as seen in Figures 1-2, Sakata et al. teaches a photovoltaic device comprising a photovoltaic element comprising

- a first conductivity type of single crystalline silicon semiconductor layer (e.g. 1 as seen in Figures 1-2);
- a substantially intrinsic non-single-crystalline semiconductor layer (or i-type a-Si layer 2 in Figure 1, 2 and 7 in Figure 2) formed on the first conductivity semiconductor layer;
- a transparent conductive oxide film (transparent electrode 5 made of ITO, or SnO_2 added In_2O_3 in Figure 1, 5 and 10 in Figure 2 - See paragraphs 0036, 0062); and
- a collector electrode of Ag (See paragraph 0036).

As seen in Figures 1-2, Sakata et al. teaches a surface of the crystalline semiconductor layer (1) is textured so that irregularities of the crystalline semiconductor is higher than the thickness of the transparent conductive oxide film (5) of 600-1500 Angstroms (or 60 nm - 150 nm - See paragraph 0036). The irregularities of the crystalline semiconductor layer are inherently higher than the height of the irregularities on the surface of the transparent conductive oxide film.

Sakata et al. does not specifically disclose the content of Sn in the transparent conductive oxide is not more than 5 percent by weight.

Yamazaki teaches a content of SnO₂ (tin oxide) in a transparent conductive oxide electrode of a solar cell is about 1-10 wt% (Sec col. 6 lines 21-24, or col. 9 line 33-34), or the Sn (e.g. tin) content is about 0.788-7.88 wt%.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to select the portions in Yamazaki's range corresponding to the claimed range of not more than 5 percent by weight for the content of Sn in the transparent conductive oxide (e.g. ITO), because Yamazaki's disclosed range of 1-10 wt% of Sn in the transparent conductive oxide is suitable. Such selection of overlapping portion of ranges has been held to be a prima facie case of obviousness. *In re Malagari*, 182 USPQ 549. Furthermore, while modified Sakata et al. teaches the broader range of Sn content, the references do not teach the exact range of Sn content of not more than 5 percent by weight. However, the routine experimental modification of modified Sakata et al. done in order to ascertain optimum operating conditions of disclosed device fails to render applicant's claims patentable in the absence of unexpected results. See *In re Aller*, 105 USPQ 233 and MPEP 2144.05. At the time of the invention a person having ordinary skill in the art would have found it obvious to optimize the Sn content in the transparent conductive oxide of modified Sakata et al and would have been motivated to do so in order to balance such operating conditions as efficiency of the device and conductivity of the transparent conductive oxide film. A prima facie case of obviousness may be rebutted, however, where the results of the optimizing variable, which is known to be result-effective, are unexpectedly good. See *In re Boesch and Slaney*, 205 USPQ 215.

Modified Sakata et al. above does not specifically disclose the transparent conductive oxide (ITO) film having an arithmetic mean deviation of the profile (or mean surface roughness) of at least 0.5 nm and not more than about 2 nm, or at least about 0.5 nm and not more than about 1 nm.

Kawai teaches the ITO layer can be polished to have a smooth surface roughness to about 1 nm (See English abstract, figures 7 and 8).

It would have been obvious to one skilled in the art at the time the invention was made to modify the device of modified Sakata et al. by polishing the ITO layer to have an arithmetic mean deviation of the profile of the transparent conductive oxide film (or surface roughness of ITO film) less than 1 nm as taught by Kawai because Kawai et al. teaches such small roughness would increase the efficiency of the solar battery (see abstract of Kawai). Once the ITO film was polished to have a roughness of less than 1 nm, i.e. from 0.5 nm to 1 nm, the transparent conductive oxide film of modified Sakata et al. has a surface with respect to which a contact of angle of water is at least about 40° and not more than about 74°, particularly in view of Applicant's disclosure (see Applicant's specification, page 35 line 23 through page 36 line 8, and Figure 8)

Modified Sakata et al. above does not specifically disclose a paste electrode formed on the transparent oxide film, wherein the paste electrode contains at least 60 percent by weight and not more than 80 percent by weight of epoxy resin; and an electric wire connected to the paste electrode by solder.

Kataoka et al. teaches a collector electrode (505) formed on the transparent conductive oxide of ITO (504), wherein the silver collector electrode in a form of paste electrode of silver

and a resin material (epoxy). (See col. 9 lines 10-29). Kataoka et al. also teaches a copper tab or a tin foil (506a) attaching to the paste electrode 505 by solder. (See col. 9 lines 30-37 or col. 14 lines 37-47). The copper tab or tin foil is corresponding to the instant electric wire. Minoru is relied upon for teaching a silver conductive paste containing thermosetting resin, wherein the thermosetting resin consist of about 60-80 wt% by weight of epoxy resin (see weight ratio of epoxy to urethane is between 10:2 to 5-10:5 in paragraph 0011 and claim 2) in the blending of epoxy and urethane resin. (See Minoru, paragraph 0011 and claim 2). It is noted that the thermosetting resin of Minoru corresponds to the instant resin binder which consist of urethane and epoxy resin.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify to device of modified Sakata et al. above by having the paste electrode of silver and epoxy resin and the electric wire connected to the paste electrode by solder as taught by Kataoka et al. with the silver conductive paste containing 60-80 wt% of epoxy in the mixture of epoxy and urethane as taught by Minoru, because Kataoka et al. teaches the electric wire such as copper tab 506a is used as an output terminal (See col. 9 lines 30-37 of Kataoka et al.) and using silver conductive paste for the electrode is nothing more than selection of a known material for its intended use which is within the ambit of one ordinary skill in the art. See *In re Leshin*, 125 USPQ 416 (CCPA 1960) (See MPEP 2144.07), and Minoru teaches the composition of silver conductive paste containing 60-80wt% epoxy would have low stress nature and heat-resistant reliability (see paragraph 0024 of Minoru).

Regarding claim 3, as seen in Figures 1-2, modified Sakata et al. discloses a photovoltaic device as described in claim 1 above, wherein Sakata et al. further teaches the photovoltaic

element further comprising a second conductivity type non-single-crystalline semiconductor layer (or p-type a-Si layer 4) formed on the intrinsic non-single-crystalline (2) and the transparent conductive oxide film (5) is formed on the second conductivity type non-single-crystalline semiconductor layer (4).

Regarding claim 4, as seen in Figure 2, modified Sakata et al. discloses a photovoltaic device as described in claim 1 above, wherein Sakata et al. further teaches the intrinsic non-single-crystalline semiconductor layer (i-type a-Si layers 2 and 7) includes first (2) and second (7) intrinsic non-single-crystalline semiconductors formed on the upper and lower surfaces of the first conductivity type single crystalline semiconductor layer (1), respectively; a second conductivity type non-single crystalline (p-type a-Si layer 4) formed on the upper surface of the first intrinsic non-single-crystalline semiconductor layer (2); a first conductivity type fourth non-single crystalline semiconductor layer (n-type a-Si semiconductor layer 9); and the transparent conductive oxide film (5 and 10 as seen in Figure 2, paragraph 0062) including a first transparent conductive oxide film (5) formed on the upper surface of the third non-single crystalline semiconductor layer (4) and a second transparent conductive oxide film (10) formed on the lower surface of the fourth non-single crystalline semiconductor layer (9) .

8. Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Sakata et al. (US 2001/0008295) in view of Kataoka et al. (US Patent 6133522), Yamazaki (US patent 4746962) and Kawai (JP 58-56479), and Minoru (JP 2002-305212) as applied to claims 1, 3-4, 6, and 10 above, and further in view of Morizane et al. (US 2001/0045505)

Regarding claim 12, modified Sakata et al. teaches a photovoltaic device as set forth above, wherein Kataoka et al. describes a plurality of the photovoltaic elements provided at a prescribed interval and connected in series by electric wires (copper tab and tin foil), wherein the photovoltaic element includes a first paste electrode (formed on the upper surface of photovoltaic element. (See Figures 1 and 5, col. 14 lines 37-47).

Modified Sakata et al does not teach a second paste electrode formed on the lower surface of the photovoltaic element.

Morizane et al. teaches using a second collector electrode (18). (See Figure 1 and paragraph [0052])

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the device of modified Sakata et al by utilizing the second collector electrode as taught by Morizane et al., because it would enable light to enter from both front and rear surfaces. (See paragraph [0051]). In such combination, it would have been obvious that the second collector electrode can be a paste collector electrode like the first collector electrode 505 of Kataoka et al. It also would have been obvious to one having ordinary skill in the art at the time the invention was made to connect the first end of the electric wire (copper tab or tin foil) to the first paste electrode of one cell and the second end of the electric wire to the second paste electrode of another cell as taught by Morizane et al., because in this way the photovoltaic elements are connected in series as taught by Kataoka et al.

9. Claims 1, 3-4, 6, and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sakata et al. (US 2001/0008295) in view of Huang (US 2004/0087252), Kataoka et al. (US Patent 6133522), and Yamazaki (US patent 4746962), and further in view of Minoru (JP 2002-305212, see machine translation)

Regarding claims 1, 6, and 10, as seen in Figures 1-2, Sakata et al. teaches a photovoltaic device comprising a photovoltaic element comprising:

- a first conductivity type of single crystalline silicon semiconductor layer (e.g. 1 as seen in Figures 1-2);
- a substantially intrinsic non-single-crystalline semiconductor layer (or i-type a-Si layer 2 in Figure 1, 2 and 7 in Figure 2) formed on the first conductivity semiconductor layer;
- a transparent conductive oxide film (transparent electrode 5 made of ITO, or SnO_2 added In_2O_3 in Figure 1, 5 and 10 in Figure 2 - See paragraphs 0036, 0062); and
- a collector electrode comprising Ag (See paragraph 0036).

As seen in Figures 1-2, Sakata et al. teaches a surface of the crystalline semiconductor layer (1) is textured so that irregularities of the crystalline semiconductor is higher than the thickness of the transparent conductive oxide film (5) of 600-1500 Angstroms (or 60 nm - 150 nm - See paragraph 0036). The irregularities of the crystalline semiconductor layer are inherently higher than the height of the irregularities on the surface of the transparent conductive oxide film.

Sakata et al. does not specifically disclose the content of Sn in the transparent conductive oxide is not more than 5 percent by weight.

Yamazaki teaches a content of SnO₂ (tin oxide) in a transparent conductive oxide electrode of a solar cell is about 1-10 wt% (Sec col. 6 lines 21-24, or col. 9 line 33-34), or the Sn (e.g. tin) content is about 0.788-7.88 wt%.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to select the portions in Yamazaki's range corresponding to the claimed range of not more than 5 percent by weight for the content of Sn in the transparent conductive oxide (e.g. ITO), because Yamazaki's disclosed range of 1-10 wt% of Sn in the transparent conductive oxide is suitable. Such selection of overlapping portion of ranges has been held to be a prima facie case of obviousness. *In re Malagari*, 182 USPQ 549. Furthermore, while modified Sakata et al. teaches the broader range of Sn content, the references do not teach the exact range of Sn content of not more than 5 percent by weight. However, the routine experimental modification of modified Sakata et al. done in order to ascertain optimum operating conditions of disclosed device fails to render applicant's claims patentable in the absence of unexpected results. See *In re Aller*, 105 USPQ 233 and MPEP 2144.05. At the time of the invention a person having ordinary skill in the art would have found it obvious to optimize the Sn content in the transparent conductive oxide of modified Sakata et al and would have been motivated to do so in order to balance such operating conditions as efficiency of the device and conductivity of the transparent conductive oxide film. A prima facie case of obviousness may be rebutted, however, where the results of the optimizing variable, which is known to be result-effective, are unexpectedly good. See *In re Boesch and Slaney*, 205 USPQ 215.

Modified Sakata et al. above does not specifically disclose the transparent conductive oxide (ITO) film having an arithmetic mean deviation of the profile (or mean surface roughness) of at least 0.5 nm and not more than about 2 nm, or at least about 0.5 nm and not more than about 1 nm.

Huang teaches the transparent conductive oxide such as ITO can be polished to have a smooth surface with surface roughness of less than 1.5 nm (see paragraph 0018) and particularly 0.87 nm (see paragraph 0021).

It would have been obvious to one skilled in the art at the time the invention was made to modify the device of modified Sakata et al. by having an arithmetic mean deviation of the profile of the transparent conductive oxide film (or surface roughness of ITO film) less than 1.5 nm or 0.87 nm as taught by Huang, because Huang teaches such roughness would decrease leakage current, improve efficiency and increase service life of the device (see paragraph 0018 of Huang). Once the selecting the portions in Huang's range of less than 1.5 nm corresponding to the claimed range of at least 0.5 nm to not more than 2 nm (i.e. from 0.5 nm to 1 nm) or a roughness of 0.87 nm was made, the transparent conductive oxide film of modified Sakata et al. has a surface with respect to which a contact of angle of water is at least about 40° and not more than about 74°, particularly in view of Applicant's disclosure (see Applicant's specification, page 35 line 23 through page 36 line 8, and Figure 8)

Modified Sakata et al. above does not specifically disclose a paste electrode formed on the transparent oxide film, wherein the paste electrode contains at least 60 percent by weight and not more than 80 percent by weight of epoxy resin; and an electric wire connected to the paste electrode by solder.

Kataoka et al. teaches a collector electrode (505) formed on the transparent conductive oxide of ITO (504), wherein the silver collector electrode in a form of paste electrode of silver and a resin material (epoxy). (See col. 9 lines 10-29). Kataoka et al. also teaches a copper tab or a tin foil (506a) attaching to the paste electrode 505 by solder. (See col. 9 lines 30-37 or col. 14 lines 37-47). The copper tab or tin foil is corresponding to the instant electric wire. Minoru is relied upon for teaching a silver conductive paste containing thermosetting resin, wherein the thermosetting resin consist of about 60-80 wt% by weight of epoxy resin (see weight ratio of epoxy to urethane is between 10:2 to 5-10:5 in paragraph 0011 and claim 2) in the blending of epoxy and urethane resin. (See Minoru, paragraph 0011 and claim 2). It is noted that the thermosetting resin of Minoru corresponds to the instant resin binder which consist of urethane and epoxy resin.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify to device of modified Sakata et al. above by having the paste electrode of silver and epoxy resin and the electric wire connected to the paste electrode by solder as taught by Kataoka et al. with the silver conductive paste containing 60-80 wt% of epoxy in the mixture of epoxy and urethane as taught by Minoru, because Kataoka et al. teaches the electric wire such as copper tab 506a is used as an output terminal (See col. 9 lines 30-37 of Kataoka et al.) and using silver conductive paste for the electrode is nothing more than selection of a known material for its intended use which is within the ambit of one ordinary skill in the art. See *In re Leshin*, 125 USPQ 416 (CCPA 1960) (See MPEP 2144.07), and Minoru teaches the composition of silver conductive paste containing 60-80wt% epoxy would have low stress nature and heat-resistant reliability (see paragraph 0024 of Minoru).

Regarding claim 3, as seen in Figures 1-2, modified Sakata et al. discloses a photovoltaic device as described in claim 1 above, wherein Sakata et al. further teaches the photovoltaic element further comprising a second conductivity type non-single-crystalline semiconductor layer (or p-type a-Si layer 4) formed on the intrinsic non-single-crystalline (2) and the transparent conductive oxide film (5) is formed on the second conductivity type non-single-crystalline semiconductor layer (4).

Regarding claim 4, as seen in Figure 2, modified Sakata et al. discloses a photovoltaic device as described in claim 1 above, wherein Sakata et al. further teaches the intrinsic non-single-crystalline semiconductor layer (i-type a-Si layers 2 and 7) includes first (2) and second (7) intrinsic non-single-crystalline semiconductors formed on the upper and lower surfaces of the first conductivity type single crystalline semiconductor layer (1), respectively; a second conductivity type non-single crystalline (p-type a-Si layer 4) formed on the upper surface of the first intrinsic non-single-crystalline semiconductor layer (2); a first conductivity type fourth non-single crystalline semiconductor layer (n-type a-Si semiconductor layer 9); and the transparent conductive oxide film (5 and 10 as seen in Figure 2, paragraph 0062) including a first transparent conductive oxide film (5) formed on the upper surface of the third non-single crystalline semiconductor layer (4) and a second transparent conductive oxide film (10) formed on the lower surface of the fourth non-single crystalline semiconductor layer (9) .

10. Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Sakata et al. (US 2001/0008295) in view of Huang (US 2004/0087252), Kataoka et al. (US Patent 6133522), and Yamazaki (US patent 4746962), and Minoru (JP 2002-305212) as applied to claims 1, 3-4, 6, 10-

11, 13, 15-16 and 21 above, and further in view of Morizane et al. (US Application Publication 20010045505)

Regarding claim 12, modified Sakata et al. teaches a photovoltaic device as set forth above, wherein Kataoka et al. describes a plurality of the photovoltaic elements provided at a prescribed interval and connected in series by electric wires (copper tab and tin foil), wherein the photovoltaic element includes a first paste electrode (formed on the upper surface of photovoltaic element. (See Figures 1 and 5, col. 14 lines 37-47).

Modified Sakata et al. does not teach a second paste electrode formed on the lower surface of the photovoltaic element.

Morizane et al. teaches using a second collector electrode (18). (See Figure 1 and paragraph [0052])

It would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the device of Sakata et al. in view of Huang, Kataoka et al., Yamazaki and Minoru by utilizing the second collector electrode as taught by Morizane et al., because it would enable light to enter from both front and rear surfaces. (See paragraph [0051]). In such combination, it would have been obvious that the second collector electrode can be a paste collector electrode like the first collector electrode 505 of Kataoka et al. It also would have been obvious to one having ordinary skill in the art at the time the invention was made to connect the first end of the electric wire (copper tab or tin foil) to the first paste electrode of one cell and the second end of the electric wire to the second paste electrode of another cell as taught by Morizane et al., because in this way the photovoltaic elements are connected in series as taught by Kataoka et al.

Response to Arguments

11. Applicant's arguments filed on January 15, 2010 have been fully considered but they are not persuasive.

Applicant argues that none of the references teaches the claimed contact angle and merely identifying a part of limitations of the claim in disparate prior art references does not automatically establish that the remainder of the limitations is inherent.

However, the examiner respectfully disagrees. The cited references teach using ITO as the transparent conductive oxide film. The references to Kloppel et al., Kawai and Huang teach forming ITO film having a small surface roughness such as less than 1 nm (see paragraph 0013 of Kloppel et al.), about 1 nm (see abstract and Figures 7-8 of Kawai et al.), less than 1.5 nm or 0.87 nm (see paragraph paragraphs 0018 and 0021 of Huang) to enhance conductivity and adhesion of the ITO film (see paragraphs 0005-0006 of Kloppel et al.) and to increase the efficiency of the device (see abstract of Kawai, paragraph 0018 of Huang). Even though the references do not explicitly disclose the contact angle of water, the contact angle of water is an intrinsic property of the surface roughness as described in Applicant's own disclosure (see page 35 line 24 to page 36 line 8 and particularly Figure 8). That is, the contact angle of water of the transparent conductive oxide film is at least about 40° and not more than about 74° when the arithmetic mean deviation of the profile Ra (or the surface roughness) of the transparent conductive oxide film is at least about 0.5 nm and not more than 2 nm (see Figure 8 in Applicant's disclosure). Therefore it is the position of the examiner that when the surface roughness of the transparent conductive oxide film is at least 0.5 nm and not more 2 nm, as

disclosed by Kloppel et al., Kawai and Huang, the surface of the transparent conductive film has a contact angle of water at least about 40° to not more than about 74°.

Conclusion

12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to THANH-TRUC TRINH whose telephone number is (571)272-6594. The examiner can normally be reached on 8:30 am - 5:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Basia Ridley can be reached on 571-272-1453. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

TT
9/27/2010

/Basia Ridley/
Supervisory Patent Examiner, Art Unit 1795